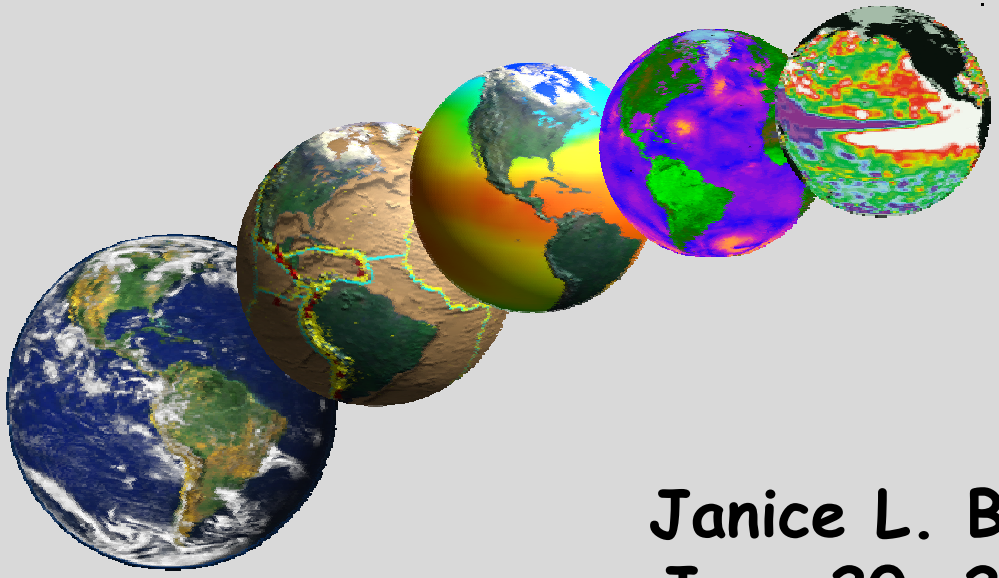
Earth Science Technology Office
Advanced Component Technology Program

Overview



Janice L. Buckner
June 20, 2003

Program Objectives

- The objectives of the ACT program are to identify, develop and demonstrate component and subsystem technologies which:
  - Reduce the risk , cost, size, and development time for Earth observing instruments, platforms and information systems and,
  - Enable new Earth observation measurements.

Program Goals

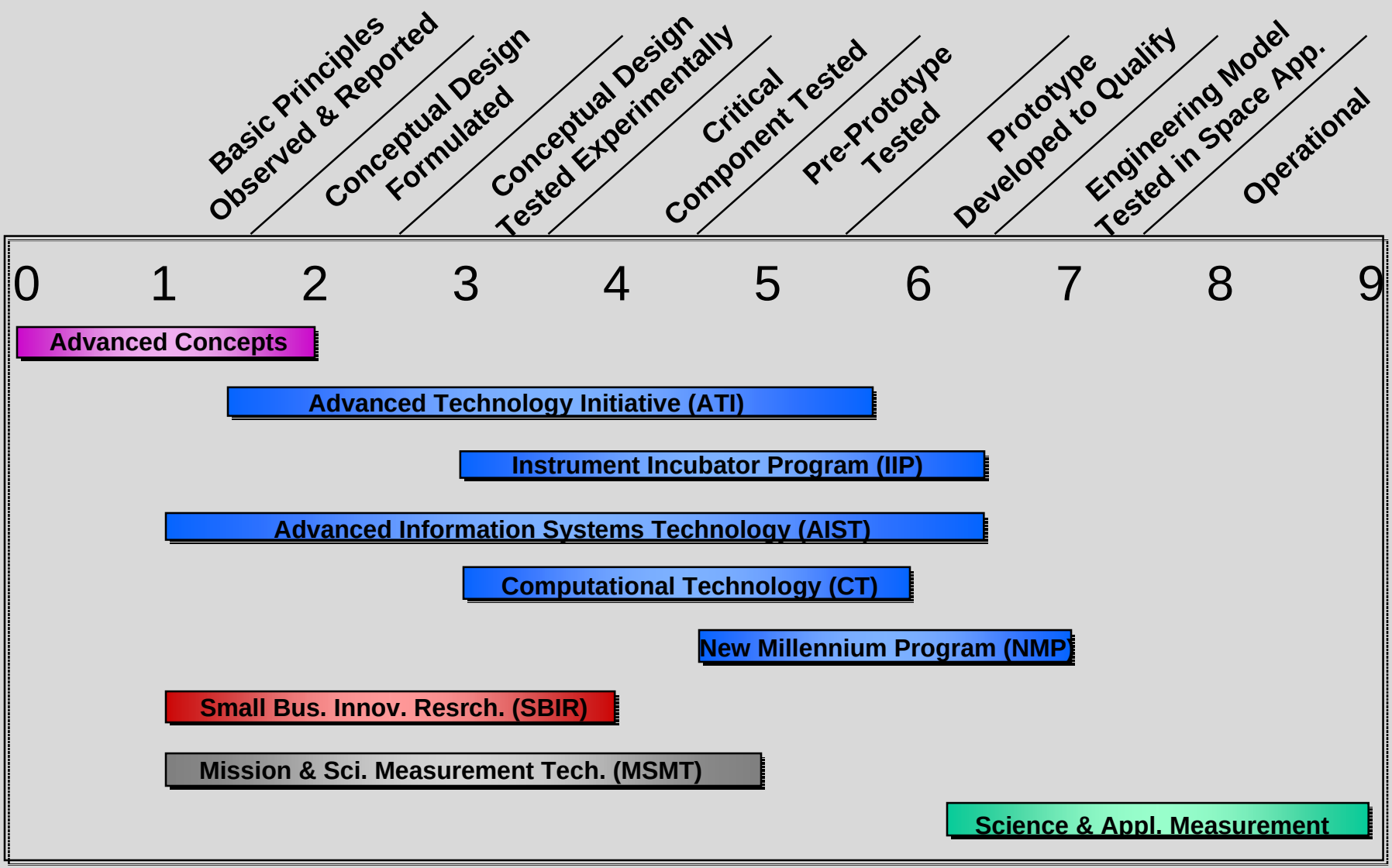
- Solicits component and subsystem technologies for Earth observing Remote Sensing Instruments
  - That enable surface, space-borne, and airborne measurements
  - Have the highest potential to meet the measurement capability requirements of the Earth Science Enterprise

Program Goals

- Seeks three classes of Instrument Components & Subsystem Technologies
  - Component and Subsystems that enable new ESE measurements
  - Components and Subsystems that reduce life cycle cost and development risks
  - Technologies that advance the state-of-the-art technology and have the potential to impact a broad set of future missions which are relevant to the ESE

Technology Program Readiness Levels

How



Science Questions

- How is the global Earth System changing?
- What are the primary forcing of the Earth System?
- How does the Earth system respond to natural and human-induced changes?
- What are the consequences of change in the Earth system for human civilization?
- How well can we predict future changes in the Earth system?

Technologies Sought in Past Solicitations

- **Antenna Technologies:**
  - Ultra lightweight large structural components such as deployable and/or inflatable booms, membranes and apertures for radiometer and synthetic aperture radar
  - Lightweight microstrip antenna technologies for microwave systems
  - Steerable microwave antenna
- **Electronics Technology:**
  - Low mass/low power stable RF electronics
  - High speed/low power digital correlators
  - Millimeter and submillimeter receiver technologies
  - Low power, high density control electronics
  - Stable power amplifiers and receivers

Technologies Sought in Past Solicitations

- **Optics Technology**
  - Optical system transform spectrometers (minimal moving parts)
  - Light weight deployable concepts for large aperture systems
  - Compact light weight optical systems
- **Detector Technologies**
  - Large Format arrays (VNIR, SWIR, FIR, and UV)
  - Cryocooler technologies, <5K
  - Linear Variable Etalons
- **Other**
  - Within the Earth Science Visions Initiative
  - Within the Capability Needs for Science, Applications and Technology
  - Within the ESE Technology Planning Workshop Proceedings

Project Characteristics

- **Development Effort**
  - Technology development activities are "best-effort", no launch date targeted.
  - Milestones occasionally adjusted throughout effort.

- **Award Characteristics**
  - Fixed-price contracts are the desired procurement vehicle used for non-governmental awards.
  - Fixed-price task are agreements used for NASA and JPL awards
  - Inter-agency agreements (fixed price) are used for other governmental agency awards.

NRA Characteristics

- Scope based upon Science and Technology focus areas
- TRL guidance
  - Entry TRL from 2 to 3
  - Exit TRL less than or equal to 5
  - Development must advance by at least one TRL
- Instrument technologies after graduating from the ACT program, may be further developed through the Instrument Incubator Program, IIP, Advanced Information Systems Program, AIST, or New Millennium, NMP.
- Solicits
  - Requirement analysis
  - Component or subsystem design
  - Engineering model construction
  - Lab demonstration
- Three year development, second and third years as options
- Award value approximately $300K annually

Funding and Performance Period

- **ACT NRA Budget**
  - Approximately $12 mission over three years
  - 10 to 15 Awards Anticipated

- **Performance Period**
  - The minimum performance period is 12 months
  - The performance period shall not exceed 36 months
  - The Government plans to award contracts for a 1-year base period, with up to two 1-year option Performance Periods

NRA Schedule

Investments in Detector Technologies

Development of Monolithic GaAs Hyperspectral Infrared QWIP Imaging System

Dr. Murzy Jhabvala, GSFC
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Objectives

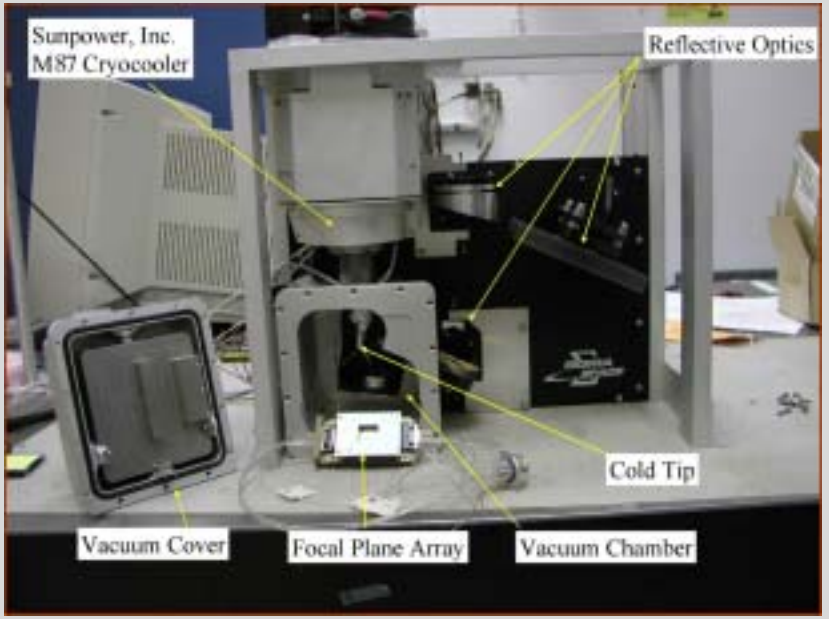
- Design and fabricate a completely monolithic four band, 512x640, GaAs Quantum Well Infrared Photodetector (QWIP) imaging array.
- Design and develop a linear variable etalon that will provide hyper-spectral imaging in each of the four bands (a total of 209 sub-bands).

Benefits

- Development of the multi-band, hyper-spectral GaAs QWIP is a major step towards achieving smaller, lighter, and lower cost imaging radiometers-particularly in missions that combine different types of remote sensing instruments. The hyper-spectral measurements, in the 3 to 15 micron region, will allow remote sounding of numerous geophysical quantities such as cloud, surface, and atmospheric parameters.

Accomplishments

- Developed a 4-band, 3-15um, 512 x 640 QWIP array
- Developed a hyperspectral LVE
- Designed and built a mechanically cooled camera system operating at 43K, need 41K
- Successfully designed and built an aircraft worthly, self contained instrument
- Obtained full hyperspectal image capability



Future Opportunities

- Currently negotiating (through NASA HQ) agreement with Thailand to establish a research effort using this technology to evaluate a variety of environmental phenomenon using low flying aircraft
- Interest from the medical community use QWIP detectors in to non-invasively identify cancers
- GOES Project has expressed interest in using technology as an alternative to long wavelength Mercury Cadmium Telluride and may be willing to fund research in improving the long wavelength performance of this QWIP
- PI is collaborating closely with the ES Directorate at GSFC for the insertion of QWIP in future ESE Missions
- This group received an ACT award to continue the development of the QWIP technology by increasing the array format to 1K x 1K

Passive Optical | TRL = 5-6

Optical Cryocooler

Optical Cryocooler Development

Gary Mills - Ball Aerospace

Background: Optical refrigeration by fluorescence is a new and unique approach to cryocoolers, unrelated to the current state-of the-art such as the Stirling cryocooler. This unique approach has the potential to provide solid state cooling to liquid nitrogen temperatures, well below 180 K, the approximate limit of thermoelectric coolers.

Application: Cooled detector package that is tightly integrated, compact, and light, with very long life (no moving parts), zero vibration, zero electromagnetic interference (EMI), and lower cost. Usable for future ESE Missions.

Optical Cryocooler Testbed

Phase 3 Summary

- Completed Photothermal Deflection tests on new materials under Ball IRAD (Cooling detected in Yb:KYW for 1st time, Yb: KGW has stronger cooling signal than Yb:ZBLAN)
- Received new yb:ZBLAN from IPG Photonics
- Cut, polished and tested samples of new Yb:ZBLAN
- Met with Research Electo Optics on polishing and coating cooling elements

Have received a 6 month no-cost extension of schedule.

Program Plans

- Yb:ZBLAN and Yb:KGW cooling elements to be polished and coated at REO.
- Yb disk laser to be purchased.
- Optimize thermal packaging
- Test in optical cryocooler test bed to achieve milestone of cooling simulated focal plane 50 degrees and perhaps more.
- Submit abstract to Cryogenic Engineering Conference to be held Sept. 2003

Small and Smart Sensor for Atmospheric Terahertz Limb Sounding

Description and Objectives

The *objective* is the development of a hot-electron heterodyne mixer based on the high temperature superconductor (HTS) $YBa_2Cu_3O_{7-d}$ or low temperature superconductor (LTS) Nb, for application to atmospheric high-resolution spectroscopy observations. This technology would enable a tunable, broadband THz instrument to meet the needs of EOS-7 mission. It could make weekly or even daily global maps of critical stratospheric molecules. It has the capability to be "re-programmed" in flight to target new molecules.

Quasioptical mixer with hybrid antenna

Accomplishments

- HTS submicron devices have been fabricated and tested at JPL. The current effort is to improve the overall HTS mixer performance.
- LTS mixers have been tested at 500-600 GHz. The experimental noise temperature is <2000K and the coupled local oscillator power is under 100 nW. These parameters meet the goals of the experimental task at 600 GHz. Similar tests are in progress at 2.5 THz.
- Analytical and experimental work has been continued to improve the understanding and design of the twin-slot antenna which is the input RF circuit for both HTS and LTS mixer.

Schedule and Deliverables

- HTS mixer noise test at 2.5 THz 06/ 2003
- LTS mixer noise test at 2.5 THz 06/2003
- Final design of the twin-slot antenna 06/2003
- Final Report 06/2003

$TRL_n=3$
TRL =4 (for 600 GHz)
TRL =3 (for 2.5 THz)


Technology is Our Future